REMARKS

Claims 1 to 30 are pending. Claims 15 to 19 have been cancelled, claims 20 to 25 are withdrawn and currently amended and claims 26 to 30 are new. No claims are allowed.

1. The Examiner indicates that claims 1 to 14 are drawn to an electrochemical storage device (Invention I), claims 15 to 19 are drawn to a method of providing a lid (Invention II) and claims 20 to 25 are drawn to a method of providing an electrical energy storage device (Invention III). The Examiner indicates that restriction for examination purposes is proper.

In the case of Inventions I and II, the product of the method does not require a terminal lead with insulating glass sealing between the lead and the ferrule. The Applicants acknowledge this distinction.

With regard to Invention I and III, the Examiner states that the product (Invention I) does not require that the outer surface of the terminal ferrule be in a normal orientation. However, this has been amended from independent method claim 20. It is now believed that the basis for restriction between Inventions I and III has been removed, which negates the restriction between these inventions.

Inventions II and III as related as combination and subcombination, and the claimed subcombination does not require a sealing glass. The Applicants acknowledge this distinction.

Accordingly, the Applicants request reconsideration of the restriction requirement between Inventions I and III.

2. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the sprue 68 and gate 70 as described on page 10 for Fig. 7. The sprue and gate are shown in Fig. 5 and the specification on page 10 has been amended accordingly.

Reconsideration of this rejection is requested.

3. Claims 1 to 14 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 to 3, 5 to 12 and 14 to 16 of U.S. Patent No. 6,986,796 to Warchocki et al. in view of Heller, Jr. et al. (U.S. Patent No. 6,010,803). The Examiner indicates that the conflicting claims are not patentably distinct because both sets recite, among other features, "a lid with an insulating terminal ferrule extending below the lid lower surface in an insulating relationship…" However, independent claims 1, 9 and 14 have been amended to delete the terminal ferrule being unitary with the lid.

Reconsideration of this rejection is requested.

4. Claims 1 to 13 are rejected under 35 USC 103(a) as being unpatentable over Heller, Jr. et al. This patent describes a lithium iodine electrochemical cell comprising a metal shell 108 closed by a lid or cover 109 to provide a container 106. The lid 109 is formed by a metal injection molding process and includes a main body portion 123 and a feedthrough ferrule 125 defining a feedthrough passage 135. The feedthrough ferrule 125 is a generally tubular member 140 having inner and outer surfaces 141, 142 terminating at a tube end 145. The feedthrough passage 135 accommodates an electrical lead 215

passing from an interior anode connection to the cell exterior where it is connected to a device powered by the cell.

The Heller, Jr. et al. cell 105 has an anode assembly 201 formed by two lithium plates 205 pressed together with a current collector 210 embedded therein. The current collector 210 may be an extension of electrical lead 215. An insulator 220 including a nonconductive, insulating material 222 that surrounds and mechanically interlocks with rings 151 is provided on the outer surface of the feedthrough ferrule 125. And, as described at column 8, lines 56 to 57 with respect to Fig. 7 "[a] part 120 of insulator portion 220 is also sandwiched between or embedded in lithium plates 205." Furthermore, as described at columns 8, lines 33 to 47, "the anode 201 is electrically insulated from the lid 109 by a band 225 of electrically non-conductive material. The band 225 peripherally encloses the anode assembly 201 . . . [and] is preferably of a fluoropolymer material or any similar material which is nonreactive with the contents of the cell . . . the opposite ends of the band 225 are provided with apertures of a size sufficient to receive part of the insulator portion 220. These ends are overlapped adjacent the insulator portion 220 to provide a wrap-around structure."

The problem with Heller, Jr. et al.'s cell is that not only must the anode 201 be electrically insulated from the lid 109; it must be electrically insulated from all cell components that are of an opposite polarity. The electrical lead 215 connected to the anode is of a negative polarity. The lid 109 including its unitary ferrule 125 is of an opposite, positive polarity. The metal sleeve 221 surrounding the insulating material 222 is also of a positive polarity because it is touching the lower

surface of the lid. According to the present invention, not only must the electrical lead 215 be insulated from any internal component of an opposite polarity including the lid, but it must also be electrically segregated from the ferrule 125 and the metal sleeve 221. The reason this is important is that in cells designed for high rate discharge applications, such as Li/SVO cells used to power implantable defibrillators, and the like, lithium dendrites can form and bridge between surfaces of opposite polarity.

The mechanism controlling lithium deposition between the positive and negative cell portions of a case negative primary lithium electrochemical cell is described in the publication by Takeuchi, E.S.; Thiebolt, W.C. *J. Electrochem. Soc.* 138, L44-L45 (1991). According to the investigators, lithium deposition is induced by a high rate intermittent discharge of a Li/SVO cell and can form "clusters" bridging between the negative case and the positive connection to the cathode. This conductive bridge can then result in an internal loading mechanism that prematurely discharges the cell.

The mechanism for lithium cluster formation is as follows: at equilibrium, the potential of a lithium anode is governed by the concentration of lithium ions in the electrolyte according to the Nernst equation. If the Li^+ ion concentration is increased over a limited portion of the electrode surface, then the electrode/electrolyte interface in that region is polarized anodically with respect to the electrode/electrolyte interface over the remaining portion of the electrode. Lithium ions are reduced in the region of higher concentration and lithium metal is oxidized over the remaining portion of the electrode until the concentration gradient is relaxed. The concentration

gradient is also relaxed by diffusion of lithium ions from the region of high concentration to low concentration. However, as long as a concentration gradient exists, deposition of lithium is thermodynamically favored in the region of high lithium ion concentration.

In a Li/SVO cell, Li^+ ions are discharged at the anode and subsequently intercalated into the cathode. The anode and cathode are placed in close proximity across a thin separator. Immediately after a pulse discharge, the Li^+ ion concentration gradient in the separator is dissipated as the Li^+ ions diffuse the short distance from the anode to the cathode and then within the pore structure of the cathode. However, at the electrode assembly edge, the anode edge is not directly opposed by the cathode edge. If excess electrolyte pools at this edge, Li^+ ions, which are discharged into the electrolyte pool, have a longer distance to diffuse to the cathode than Li^+ ions discharged into the separator. Consequently, this electrolyte pool maintains a higher concentration of Li^+ ions for a longer period of time after the pulse discharge.

Typically, the lithium anode tab is welded to the inside of the cell casing. Therefore, if these components are also wetted by excess electrolyte, this concentration gradient extends over the tab and casing, and lithium cluster deposition is induced onto these surfaces by the Nernstian anodic potential shift derived from the higher Li^+ ion concentration in the excess electrolyte pool after the pulse discharge. More generally, however, lithium cluster deposition is possible between any two components of opposite polarity that are in relatively close proximity with each other and wetted by electrolyte.

Therefore, looking at Fig. 7 as an example, it is clear that

a portion of the lead 215 immediately below the lower end of the ferrule is uncovered by the part 120 of insulator portion 220. This is even though insulator part 120 is received in an opening at the overlap of the non-conductive peripheral band 225. It does not appear as though part 125 is connected to insulator portion 220, leaving a portion of lead 215 above the overlapped peripheral band 225 but below the ferrule tube end 145 exposed. In high rate discharge applications this is precisely such an edge location where lithium dendrites could form and bridge across opposite polarity components; in this case from the exposed lead to the ferrule 125 or the metal sleeve 221. Even though Heller, Jr. et al. state at column 9, lines 13 to 32, that their invention is applicable to high rate cells, it is clear that their primary focus was a metal injection molded cover for a low rate, lithium iodine cell. Otherwise, more care would have been taken to ensure that no two components of opposite polarity were "exposed" to each other.

In that light, independent claims 1 and 9 have been amended to set forth that the terminal lead is of an opposite polarity as the casing and that a sealing material seals between the terminal lead and an inner surface of the ferrule sidewall. Then, an insulator encases the terminal lead "from a lower surface of the sealing material to a location spaced between the lower ferrule surface a sufficient distance to segregate the opposite polarity casing including the lid and terminal ferrule from the terminal lead". See amended claim 1.

Support for this is shown in Fig. 3 and 4 and described at page 9, line 15 to page 10, line 2. There, the Applicants state that "Fig. 4 further shows a thermoplastic insulator 56 encasing the ferrule 22 and a portion of the terminal lead 44. A

preferred thermoplastic material is a fluoro-polymer, for example polytetrafluoroethylene (PTFE) that surrounds the ferrule 22 from the lower surface 14 of the lid 10 and continues along a portion of the length of the terminal lead 44 to a distance spaced from the ferrule. The annular rings 30 of the ferrule 22 provide a discontinuous pathway that helps maintain a hermetic seal between the thermoplastic insulator and the ferrule. Also, thermoplastic materials generally flow better around and into annular rings than traditional threads. A lower portion 58 of the terminal lead 44 is left uncovered for subsequent connection to the cathode current collector 46, as described above. The primary function of the insulator 56 is to help segregate the anode from the cathode in the vicinity of the lid 10." Further support is found at page 3, lines 18 to 20.

Accordingly, it is believed that amended independent claims 1 and 9 are neither anticipated by Heller, Jr. et al., nor would they have been obvious in light of this patent's teachings. Simply, the cited patent is directed to low rate cell chemistries where complete and thorough isolation of opposite polarity internal components is not critical. In contrast, with high rate cells that experience Li^+ concentration gradients as a result of pulse discharge, uncovered components of opposite polarity, especially those directly facing each other, are potential sites of lithium dendrite bridging, which can result in an internal load mechanism or an internal short. Claims 2 to 8 and 10 to 13 are allowable as hinging from patentable base claims.

Reconsideration of this rejection is requested.

5. Claim 14 is rejected under 35 USC 103(a) as being unpatentable over Heller, Jr. et al. in view of Ben-Haim (U.S. Patent No. 6,463,324). The secondary reference is cited for its teaching of a pacemaker with a controller. However, independent claim 14 has been amended in a similar manner as amended independent claims 1 and 9. As such, it is believed to be patentable over Heller, Jr. et al., and the secondary Ben-Haim reference does not adversely impact this.

Reconsideration of this rejection is requested.

6. New claims 26 to 28 have been added to depend from independent claims 1, 9 and 14, respectively, and to set forth that the lid and ferrule are unitary. New claim 29 covers various chemistries that are useful with the claimed electrical energy storage device of claim 1. Finally, new independent claim 30 is directed to a specific high rate cell chemistry embodying the novel terminal lead/insulator/ferrule structure set forth in amended independent claim 1.

It is believed that claims 1 to 14 and 20 to 30 are now in condition for allowance. Notice of Allowance is requested.

Respectfully,

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September 14, 2006